CEMENT AND LIME MANUFACTURE

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CEMENT AND LIME MANUFACTURE

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Comparison of the Portland Cement Specifications of the World.

Some requirements of the latest standard specifications for Portland cement are given in the tables on pages 42 to 51 for most countries in the world. The standards of many countries have been revised since the war, and revised standards published in some countries during the war have only recently become available in Britain. Only Portland cements are included, and these are classified as low-strength, ordinary, rapid-hardening, high-strength, moderate low-heat and moderate sulphate-resistant, low-heat, and sulphate-resistant Portland cements. Air-entraining Portland cements are not included.

The requirements include Chemical composition (*Table No. I*), Setting time and soundness (*Table No. II*), Strength in pounds per square inch (*Table No. III*) and in kilogrammes per square centimetre (*Table No. IIIA*), Fineness (*Table No. IV*), and Methods of preparing specimens for the strength tests (*Table No. V*). *Tables Nos. IIIA, IV* and *V* will appear in a later number.

The chemical composition includes the permitted amount of MgO, SO_3, insoluble residue, loss on ignition, and additions; the limiting ratio of CaO to the other oxides (allowance being made for the CaO combining with the SO_3 when so specified); any restrictions on the amounts of other oxides or compounds specified in the case of some special Portland cements; the heat of hydration of low-heat cements; and the specific gravity (when specified). The setting times include initial and final times, and the method of determining the soundness (that is by hot or cold pat test, the Le Chatelier apparatus, or by autoclave) is indicated. The consistency of and method of making the specimens for the foregoing tests and for the tensile, compressive, and bending tests (some of which are not required and some of which are optional) are also given in the tables. The degree of fineness required is expressed either as the result of sieve analysis or as the specific surface, the apparatus to be used in determining the latter being indicated.

Some countries, including Bolivia, Iran, and certain republics in Central America do not have national standards for Portland cement. Other countries, some of which are mentioned in the tables, adopt the standards of Britain, the United States, or other nations.

TABLE I.—CHEMICAL COMPOSITION OF PORTLAND CEMENT.

NOTES.

(1) The following countries, which adopt the standards of other countries, are omitted: Egypt (O. as Britain, 1947); Iceland (O., as Denmark, 1933); India (O., as Britain, 1947); Jamaica (O., as Britain, 1947); Paraguay (as Argentina); Peru (as United States); South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement: H.S., high strength; L.H., low heat; L.S., low strength; M.L.H., moderate low heat; M.S.R., moderate sulphate resistant; O., ordinary; R.H., rapid hardening; S.R., sulphate resistant.

(3) Chemical abbreviations: C = CaO; S = SiO_2; A = Al_2O_3; F = Fe_2O_3; Mn = Mn_2O_3; R = R_2O_3; C_3A = $3CaO.Al_2O_3$, etc.

(4) Permitted tolerances are given in brackets.

(5) Permitted additions exclude water and $CaSO_4$ (added to regulate the setting time) unless specifically stated otherwise.

Country and date of Standard (See Note 1)	Type of Cement (See Note 2)	Chemical Ratios based on percentages (See Note 3)	Maximum Percentage (See Note 4)					Remarks
			MgO	SO_3	Insoluble residue	Loss on ignition	Permitted additions (See Note 5)	
Argentina (1947)	O. R.H.	$\frac{C}{S+A+F} \not< 1{\cdot}7$	4·0	2·5	1·0	3·0	None	—
Australia (1948)	O. R.H.	—	4·0 (+ 0·25)	2·75 (+ 0·10)	2·0 (+ 0·15)	3·0 (+ 0·15)	None	—
Belgium (1941)	O. H.S. R.H.	—	3·0	3·0	—	—	None	Specific gravity $\not<$: 3·05
Brazil (O.—1937 R.H.—1940)	O.	—	6·0 (+ 0·40)	2·5 (+ 0·15)	0·85 (+ 0·15)	4·0 (+ 0·30)	None	—
	R.H.	—	5·0 (+ 0·30)	2·5 (+ 0·15)	0·85 (+ 0·15)	4·0 (+ 0·30)	1·0	—
Britain (1947)	O. R.H.	$\frac{C-0{\cdot}7\,SO_3}{2{\cdot}8S+1{\cdot}2A+0{\cdot}65F} \not< 0{\cdot}66 \not> 1{\cdot}02$ $\frac{A}{F} \not< 0{\cdot}66$	4·0	2·75	1·0	3·0 or 4·0 in hot climates	None	—
	L.H.	$\frac{C-0{\cdot}7SO_3}{2{\cdot}4S+1{\cdot}2A+0{\cdot}65F} \not> 1{\cdot}0$ $\frac{C-0{\cdot}7SO_3}{1{\cdot}9S+1{\cdot}2A+0{\cdot}65F} \not< 1{\cdot}0$ $\frac{A}{F} \not< 0{\cdot}66$	4·0	2·75	1·0	3·0	None	Heat of hydration (max.): 7 days: 65 calories per gr. 28 „ 75 „ „ „

Bulgaria (1941)	O. R.H.	$\frac{C}{S+A+F} \leqslant 1.7$	5·0	3·0	—	5·0	3·0	—
Canada (O., R.H.—1940. S.R.—1942)	O.	—	4·0 (+ 0·40)	2·0 (+ 0·20)	0·75 (+ 0·15)	3·0 (+ 0·25)	None	
	R.H.	—	4·0 (+0·40)	2·5 (+ 0·20)	0·75 (+ 0·15)	3·0 (+ 0·25)	None	
	S.R.	$\frac{S}{A+F} \leqslant 2.8$ $\frac{F}{A} \geqslant 1.3$	3·0 (+ 0·30)	2·0 (+ 0·20)	0·5 (+ 0·10)	3·0 (+ 0·30)	None	$A \geqslant 4$ (+ 0·40) per cent. $C_3A \geqslant 4$ (+ 0·40) per cent.
Chile (1941)	O. H.S.	$\frac{C - 0.7SO_3}{S+A+F+Mn} \leqslant 1.7$	2·0	2·0	1·5	3·0	None	Specific gravity $\leqslant 3.05$. For marine work $\frac{S}{A+F} \geqslant 2.2$
China (1934)	O.	—	4·0	2·75	1·0	4·0	—	—
Czechoslovakia (1947)	O. R.H.	—	6·0	3·0	—	—	—	—
Denmark (O.—1933 R.H.—1942)	O.	$\frac{C}{S+A+F} \leqslant 1.8$	3·0	—	—	—	3*	*Including gypsum
	R.H.		3·0	3·0 (+ 0·2)	—	—	6*	
Eire (1946)	O. R.H.	$\frac{C - 0.7SO_3}{2.8S + 1.2A + 0.65F} \leqslant 0.66 \geqslant 1.00$ $\frac{F}{A} \geqslant 1.5$	4·0	2·75	1·0	4·0	None	—
Finland (1945)	O.	—	5·0	—	—	—	15	—
	R.H.	—	5·0	—	—	—	3	—
	L.H.	—	5·0	—	—	—	15	Heat evolved (1 : 6 mixture) : 3 days : 55 cal. per g. (max.) 7 ,, 65 ,, ,,
France (1946)	O. R.H.	—	5·0	3·0	3·0	4·0	3·0	
Germany (1942)	L.S. O. R.H.	—	5·0	3·0	—	5·0	1·0	—
Italy (1939)	O. H.S.	$\frac{C}{S+R} \leqslant 1.7$	3·0	2·5	1·5	5·0	None	—
Japan (1941)	O. R.H.	—	3·0	2·0	—	4·0	None	Specific gravity $\leqslant 3.05$

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TABLE I.—CHEMICAL COMPOSITION OF PORTLAND CEMENT. (*Cont.*)

NOTES.

(1) The following countries, which adopt the standards of other countries, are omitted: Egypt (O., as Britain, 1947); Iceland (O., as Denmark, 1933); India (O., as Britain, 1947); Jamaica (O., as Britain, 1947); Paraguay (as Argentina); Peru (as United States); South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement: H.S., high strength; L.H., low heat; L.S., low strength; M.L.H., moderate low heat; M.S.R., moderate sulphate resistant; O., ordinary; R.H., rapid hardening; S.R., sulphate resistant.

(3) Chemical abbreviations: $C = CaO$; $S = SiO_2$; $A = Al_2O_3$; $F = Fe_2O_3$; $Mn = Mn_2O_3$; $R = R_2O_3$; $C_3A = 3CaO.Al_2O_3$, etc.

(4) Permitted tolerances are given in brackets.

(5) Permitted additions exclude water and $CaSO_4$ (added to regulate the setting time) unless specifically stated otherwise.

Country and date of Standard (See Note 1)	Type of Cement (See Note 2)	Chemical Ratios based on percentages (See Note 3)	Maximum Percentage (see Note 4)					Remarks
			MgO	SO_3	Insoluble residue	Loss on ignition	Permitted additions (See Note 5)	
Mexico (1943)	O.	—	4·0	2·0	0·75	3·0	1·0	Alkalis $\gtrless$ 1·2 per cent.
	R.H.	—	4·0	2·5	0·75	3·0	1·0	Alkalis $\gtrless$ 1·2 per cent. $C_3A \gtrless$ 5 per cent.
	M.L.H. M.S.R.	$\frac{A}{F} \lessgtr 0{\cdot}7 \gtrless 2{\cdot}0$	4·0	2·0	0·75	3·0	1·0	S $\lessgtr$ 21 per cent.; A $\gtrless$ 6 per cent. $C_3A \gtrless$ 8 per cent. F $\lessgtr$ 6 per cent. $C_2S \lessgtr$ 50 per cent. Alkalis $\gtrless$ 0·9 per cent.
	L.H.	$\frac{A}{F} \lessgtr 0{\cdot}7 \gtrless 2{\cdot}0$	4·0	2·0	0·75	2·3	1·0	Alkalis $\gtrless$ 0·8 per cent. S $\lessgtr$ 21 per cent.; F $\gtrless$ 6 per cent. $C_3S \lessgtr$ 30 per cent.; $C_3A \gtrless$ 7 per cent. $C_2S \lessgtr$ 40 per cent.
	S.R.	$\frac{A}{F} \lessgtr 0{\cdot}7 \gtrless 2{\cdot}0$	4·0	2·0	0·75	2·5	1·0	S $\lessgtr$ 24 per cent.; A $\gtrless$ 4 per cent. F $\gtrless$ 4 per cent.; $C_3A \gtrless$ 5 per cent. Alkalis $\gtrless$ 0·9 per cent.
Netherlands (1933)	O. R.H.	$\frac{C}{S + A + F} \lessgtr 1{\cdot}7$	5·0	2·5	3·0	—	None	—
Norway (1934)	O. R.H.	$\frac{C}{S + A + F + Mn} \lessgtr 1{\cdot}7 \gtrless 2{\cdot}4$	4·0	2·75	1·5	4·0	None	Specific gravity $\lessgtr$ 3·05
Palestine (1947)	O. R.H.	$\frac{C - 0{\cdot}7SO_3}{2{\cdot}8S + 1{\cdot}2A + 0{\cdot}65F} \lessgtr 0{\cdot}67 \gtrless 1{\cdot}0$ $\frac{F}{A} \gtrless 1{\cdot}5$	4·0	2·75	1·0	4·0	None	—

Poland (O.—1946 H.S.—1948)	O.	—	5·0	2·5	1·5	5·0	None	—
	H.S.	$\frac{C}{S+A+F} < 1{\cdot}7 > 2{\cdot}3$	5·0	3·0	1·5	3·0	—	—
Portugal (L.S., O.—1930. L.H.—1946. S.R.—1932)	L.S.	—	4·0	2·5	1·5	4·0	None	Specific gravity < 3·05
	O.	—	(+ 0·40)	(+ 0·10)	(+0·15)	(+ 0·30)		
	L.H.	—	5·0	2·0	0·75	2·3	—	F > 6·5 per cent. ; C_3S > 35 per cent. C_3A > 7 per cent. ; C_2S < 40 per cent.
	S.R.	$\frac{C}{S+A+F} < 1{\cdot}8 > 2{\cdot}2$	3·0	2·0	1·5 (+ 0·15)	4·0 (+0·3)	None	Specific gravity < 3·05 A > 8 per cent.
Roumania (1934)	O. H.S. R.H.	$\frac{C}{S+A+F} < 1{\cdot}7 > 2{\cdot}2$	5·0	3·0	—	—	—	Specific gravity < 2·9 > 3·3
Russia (1936)	O. R.H.	—	4·5	2·5	—	4·0	10·0*	*Including gypsum Specific gravity < 3·0 > 3·2
Spain (1930)	O. R.H.	$\frac{C}{S+A+F} > 2{\cdot}3 < 1{\cdot}8$	5·0	2·5	1·5	4·0	3·0	Specific gravity < 3·05
Sweden (1943)	O. R.H.	—	—	—	—	—	3·0	—
	L.H.	—	—	—	—	—	3·0	Heat evolved (1 : 6 mixture) 3 days : 55 cals. per g. 7 days : 65 cals. per g.
Switzerland (1945)	O. H.S.	$\frac{C}{S+R} > 2{\cdot}0$	4·0 (+ 1·2)	2·5 (+ 0·75)	5·0 (+ 1·5)	—	10·0*	* Including gypsum Specific gravity < 3·0 > 3·2
Turkey (1937)	O. R.H.	$\frac{C}{S+A+F} < 2{\cdot}0$	4·0	2·5	0·85	3·0	3·0*	*Including gypsum Specific gravity < 3·05
United States of America (1947)	Type I(O.)	—	5·0	2·0†	0·75	3·0	1·0	† 2·5 if $C_3A > 8$ per cent.
	Type II (M.S.R., M.L.H.)	$\frac{A}{F} < 0{\cdot}7 > 2{\cdot}0$	5·0	2·0	0·75	3·0	1·0	S < 21 per cent. ; A > 6 per cent. F > 6 per cent. ; C_3S > 50 per cent. C_3A > 8 per cent.
	Type III (R.H.)	—	5·0	2·5†	0·75	3·0	1·0	C_3A > 15 per cent. † 3·0 if $C_3A > 8$ per cent.
	Type IV (L.H.)	—	5·0	2·0	0·75	2·3	1·0	F > 6·5 per cent. ; C_3S > 35 per cent. C_2S < 40 per cent. ; C_3A > 7 per cent.
	Type V (S.R.)	$\frac{A}{F} < 0{\cdot}7 > 2{\cdot}0$	4·0	2·0	0·75	3·0	1·0	A > 4 per cent. ; F > 5 per cent. C_3S > 50 per cent. ; C_3A > 5 per cent.
Uruguay (1945)	O.	—	4·0	2·5	0·85	3·0	1·0	—
	R.H.	—	4·0	2·5	0·85	3·0	1·0	C_3A > 15 per cent.
Venezuela (1941)	O.	—	5·0	2·0	0·75	3·0	—	—
Yugoslavia (1931)	O. H.S.	$\frac{C}{S+R} > 1{\cdot}7$	5·0	3·0	—	—	—	—

TABLE II.—SETTING-TIME AND SOUNDNESS OF PORTLAND CEMENT.

NOTES.

(1) The following countries, which adopt the standards of other countries, are omitted: Egypt (O., as Britain, 1947); Iceland (O., as Denmark, 1933); India (O., as Britain, 1947); Jamaica (O., as Britain, 1947); Paraguay (as Argentina); Peru (as United States); South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement: H.S., high strength; L.H., low heat; L.S., low strength; M.L.H., moderate low heat; M.S.R., moderate sulphate resistant; O., ordinary; R.H., rapid hardening; S.R., sulphate resistant.

(3) Setting times are measured by the Vicat method unless stated otherwise.

(4) *N* is the percentage of water required to form a paste which permits the 1-cm. diameter plunger of the Vicat apparatus to settle to a point 5 mm. to 7 mm. from the base of the mould.

(5) X signifies that pat test is used. Hot-pat test: Pats (or balls) cured for 24 hours in water and then for 3 hours to 5 hours in boiling water (or steam). Cold-pat test: Pats cured for 28 days in water. Autoclave test: Specimens 1 in. by 1 in. by 10 in.

Country and date of Standard (See Note 1)	Type of Cement (See Note 2)	Setting Times (See Note 3)			Soundness Tests (See Note 5)					Remarks
								Expansion (max.)		
		Water (See Note 4)	Initial (minimum) minutes	Final (maximum) hours	Water (See Note 4)	Hot Pat Test	Cold Pat Test	Le Chatelier mm.	Autoclave per cent.	
Argentina (1947)	O. and R.H.	*N*	45	10	*N*	—	—	—	1·3	—
Australia (1948)	O. and R.H.	*N*	60	12	*N*	X	—	5*	—	*2·5 mm. after 7 days' aeration
Belgium (1941)	O., H.S. and R.H.	*N*	45	⊀ 3 ⊁ 12	*N*	—	—	6†	—	†6 mm. cold water 6 mm. boiling 10 mm. total
Brazil (O.—1937 R.H.—1940)	O.	*N*	60	—	*N*	—	—	10	—	—
	R.H.	*N*	60	—	*N*	—	—	3	—	—
Britain (1947)	O. and R.H.	0·85 *N*	30	10	0·78 *N*	—	—	10*	—	*5 mm. after 7 days' aeration
	L.H.	0·78 *N*	60	10	0·78 *N*	—	—	10*	—	
Bulgaria (1941)	O. and R.H.	*N*	60	12	*N*	X	X	—	—	—
Canada (O., R.H.—1940. S.R.—1942)	O. and R.H.	*N*	45	8	*N*	X	—	—	—	—
	S.R.	*N*	45	10	*N*	X	—	—	—	—

Chile (1941)	O. and H.S.	*N*	60	10	*N*	X	X	—	—	—
China (1934)	O.	*N*	30	10	*N*	—	X	—	—	—
Czechoslovakia (1947)	O. and R.H.	*N*	60	15	*N*	X	X	—	—	—
Denmark (O.—1933 R.H.—1942)	O.	*N*	60	15	*N*	—	X	10	—	—
	R.H.	*N*	45	15	*N*	—	X	10	—	—
Eire (1946)	O. and R.H.	0·78 *N*	30	10	0·78 *N*	—	—	5*	—	*2·5 mm. after 7 days' aeration
Finland (1945)	O.	*N*	∢ 45 ∗ 360	—	*N*	—	—	—	1·0	—
	R.H.	*N*	∢ 60 ∗ 360	—	*N*	—	—	—	1·0	—
	L.H.	*N*	∢ 120 ∗ 480	—	*N*	—	—	—	1·0	—
France (1946)	O. and R.H.	*N*	30	—	*N*	—	—	10	—	—
Germany (1942)	O. and H.S.	*N*	60	12	*N*	X	X	—	—	—
Italy (1939)	O. and H.S.	*N*	60	∢ 4	*N*	—	—	10	—	—
Japan (1941)	O. and R.H.	*N*	60	10	*N*	X	X	—	—	—
Mexico (1943)	All types	*N*	60††	10	*N*	X	—	—	1·0	††By Gillmore test
Netherlands (1933)	O. and R.H.	*N*	60	—	*N*	X	X	10*	—	*After 1 day aertion
Norway (1934)	O. and R.H.	*N*	60	10	*N*	X	X	5	—	—
Palestine (1947)	O. and R.H.	*N*	45	10	*N*	—	—	10	—	—
Poland (O.—1946 H.S.—1948)	O.	*N*	40	10	*N*	X	X	—	—	—
	H.S.	*N*	40	10	*N*	X	X	—	—	—
Portugal (O.—1930 L.H.—1946 S.R.—1932)	O. and S.R.	*N*	60	8	*N*	—	—	4	—	—
	L.H.	*N*	45	10	*N*	—	—	4	—	—
Roumania (1934)	O., H.S. and R.H.	*N*	60	—	*N*	X	X	10	—	—
Russia (1936)	O. and R.H.	*N*	30	10	*N*	X	X	—	—	—
Spain (1930)	O.	*N*	45	12	*N*	X	X	—	—	—
	R.H.	*N*	30	10	*N*	X	X	—	—	—

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TABLE II.—SETTING-TIME AND SOUNDNESS OF PORTLAND CEMENT. (*Cont.*)

NOTES

(1) The following countries, which adopt the standards of other countries, are omitted : Egypt (O., as Britain 1947) ; Iceland (O., as Denmark, 1933) ; India (O., as Britain, 1947) ; Jamaica (O., as Britain, 1947) ; Paraguay (as Argentina) ; Peru (as United States) ; South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement : H.S., high strength ; L.H., low heat ; L.S., low strength ; M.L.H., moderate low heat ; M.S.R., moderate sulphate resistant ; O., ordinary ; R.H., rapid hardening ; S.R., sulphate resistant.

(3) Setting times are measured by the Vicat method unless stated otherwise.

(4) *N* is the percentage of water required to form a paste which permits the 1-cm. diameter plunger of the Vicat apparatus to settle to a point 5 mm. to 7 mm. from the base of the mould.

(5) X signifies that pat test is used. Hot-pat test : Pats (or balls) cured for 24 hours in water and then for 3 hours to 5 hours in boiling water (or steam). Cold-pat test : Pats cured for 28 days in water. Autoclave test : Specimens 1 in. by 1 in. by 10 in.

Country and date of Standard (See Note 1)	Type of Cement (See Note 2)	Setting Times (See Note 3)			Soundness Tests (See Note 5)					Remarks
		Water (See (Note 4)	Initial (minimum) minutes	Final (maximum) hours	Water (See Note 4)	Hot Pat Test	Cold Pat Test	Expansion (max.)		
								Le Chatelier mm.	Autoclave per cent.	
Sweden (1943)	O.	*N*	⩽60 ⩾360	—	*N*	—	—	—	1·0	—
	R.H.	*N*	⩽45 ⩾360	—	*N*	—	—	—	1·0	—
	L.H.	*N*	⩽180 ⩾480	—	*N*	—	—	—	1·0	—
Switzerland (1945)	O. and H.S.	*N*	150‡	7‡	*N*	X	—	8	—	‡Not substantiallly less than these times
Turkey (1937)	O. and R.H.	*N*	60	12	*N*	—	—	8	—	—
United States of America (1947)	All types	*N*	45††	10	—	—	—	—	0·5	†† Or 60 by Gillmore test
Uruguay (1945)	O. and R.H.	*N*	45	10	*N*	—	—	5	0·5	—
Venezuela (1941)	O.	*N*	45	6	*N*	X	—	—	0·5	—
Yugoslavia (1931)	O. and H.S.	*N*	60	15	*N*	X	X	—	—	—

TABLE III.—STRENGTH OF PORTLAND CEMENT (LB. PER SQUARE INCH).

NOTES.—For dates of Standards see Table I.

(1) The following countries, which adopt the standards of other countries, are omitted: Egypt (O., as Britain, 1947); Iceland (O., as Denmark, 1933); India (O., as Britain, 1947); Jamaica (O., as Britain, 1947); Paraguay (as Argentina); Peru (as United States); South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement: H.S., high strength; L.H., low heat; L.S., low strength; M.L.H., moderate low heat; M.S.R., moderate sulphate resistant; O., ordinary; R.H., rapid hardening; S.R., sulphate resistant.

(3) Strengths are measured on 3 sand : 1 cement mortar except where indicated otherwise. Tests marked* are optional. c.s. = combined wet and dry storage.

Country (see Note 1)	Type of Cement (see Note 2)	Tensile Strength Age of specimen in days						Bending Strength Age of specimen in days				Compressive Strength Age of specimen in days					
		1	2	3	7	28	28(c.s.)	1	3	7	28	1	2	3	7	28	28 (c.s.)
Argentina	O.	—	—	—	235	398	—	—	—	—	—	—	—	—	3270	4620	—
	R.H.	285	356	427	498	—	712	—	—	—	—	3200	4980	5690	6400	—	8540
Australia	O.	—	—	—	—	—	—	—	—	—	—	—	—	2500	3500	4500	—
	R.H.	—	—	—	—	—	—	—	—	—	—	—	—	4000	5500	6500	—
Belgium	O.	—	—	256	327	384	—	—	—	—	—	—	—	2845	4266	5690	—
	H.S.	—	—	327	384	427	—	—	—	—	—	—	—	4266	5690	7110	—
	R.H.	285	—	384	427	—	—	—	—	—	—	3200	—	5690	7110	—	—
Brazil	O.	—	—	—	—	—	—	—	—	—	—	—	—	1140	2133	3556	—
	R.H.	—	—	—	—	—	—	—	—	—	—	1565	—	3129	4409	—	—
Bulgaria	O.	—	—	—	256	356	427	—	—	—	—	—	—	—	2845	4267	5690
	R.H.	—	—	356	—	427	569	—	—	—	—	—	—	3560	—	5690	7112
Britain	O.	—	—	300	375	—	—	—	—	—	—	—	—	1600	2500	—	—
	R.H.	300	—	450	—	—	—	—	—	—	—	1600	—	3500	—	—	—
	L.H.	—	—	—	—	—	—	—	—	—	—	—	—	1000	1600	3750	—
Canada	O.	—	—	200	275	350	—	—	—	—	—	—	—	—	—	—	—
	R.H.	275	—	375	—	—	—	—	—	—	—	—	—	—	—	—	—
	S.R.	—	—	150	250	350	—	—	—	—	—	—	—	—	—	—	—
Chile	O.	—	—	—	356	427	—	—	—	—	—	—	—	—	3556	4978	—
	H.S.	—	—	356	427	540	—	—	—	—	—	—	—	3556	4978	6400	—
China	O.	—	—	—	256	356	—	—	—	—	—	—	—	—	2560	3910	—
	H.S.	—	—	356	—	427	—	—	—	—	—	—	—	3556	—	5690	—
Czechoslovakia	O.	—	—	—	256	356	427	—	—	—	—	—	—	—	2845	3910	4978
	R.H.	—	—	356	398	427	569	—	—	—	—	—	—	3910	5334	6045	7112

TABLE III.—STRENGTH OF PORTLAND CEMENT (LB. PER SQUARE INCH). (*Cont.*)

NOTES.—For dates of Standards see Table I.

(1) The following countries, which adopt the standards of other countries, are omitted: Egypt (O., as Britain, 1947); Iceland (O., as Denmark, 1933); India (O., as Britain, 1947); Jamaica (O., as Britain, 1947); Paraguay (as Argentina); Peru (as United States); South Africa (O. and R.H., as Britain, 1947).

(2) Abbreviations of types of cement: H.S., high strength; L.H., low heat; L.S. low strength; M.L.H., moderate low heat; M.S.R., moderate sulphate resistant; O., ordinary; R.H., rapid hardening; S.R., sulphate resistant.

(3) Strengths are measured on 3 sand : 1 cement mortar except where indicated otherwise. Tests marked * are optional. c.s. = combined wet and dry storage.

Country (see Note 1)	Type of Cement (see Note 2)	Tensile Strength Age of specimen in days						Bending Strength Age of specimen in days				Compressive Strength Age of specimen in days					
		1	2	3	7	28	28(c.s.)	1	3	7	28	1	2	3	7	28	28 (c.s.)
Denmark	O.	—	—	—	284*	356*	427*	—	—	—	—	—	—	—	4551	5690	6400
	R.H.	—	—	284	284	356	427	—	—	—	—	—	—	4267	4551	5690	6400
Eire	O.	—	—	330	430	—	—	—	—	—	—	—	—	—	—	—	—
	R.H.	300	—	455	—	—	—	—	—	—	—	—	—	—	—	—	—
Finland	O.	—	—	—	—	—	—	—	427*	569	853	—	—	2133*	3200	4978	—
	R.H.	—	—	—	—	—	—	356*	712	853*	996	1422*	—	4267	5334*	6400	—
	L.H.	—	—	—	—	—	—	—	—	427*	712	—	—	—	1778*	3556	90 days 4978
France	O.	—	—	—	284*	356*	—	—	—	—	—	—	—	—	2276	3556	—
	R.H.	—	256	—	356	427	—	—	—	—	—	—	2276	—	4480	5689	—
Germany	L.S.	—	—	—	—	—	—	—	—	356*	712	—	—	—	1565*	3200	—
	O.	—	—	—	—	—	—	—	427*	569	853	—	—	2133*	3200	4622	—
	R.H.	—	—	—	—	—	—	356*	711	853*	996	1422*	—	4267	5120*	6045	—
Italy	O.	—	—	—	370	455	—	—	—	—	—	—	—	—	5405	7112	—
	R.H.	—	—	299	441	526	—	—	—	—	—	—	—	4125	7112	9672	—
Japan†	O.	—	—	—	—	—	—	—	142	284	427	—	—	498	996	2418	—
	R.H.	—	—	—	—	—	—	—	284	498	782	—	—	1138	2276	3556	—
Mexico‡	O.	—	—	142	270	341	—	—	—	—	—	—	—	711	1422	2133	—
	R.H.	270	—	370	—	—	—	—	—	—	—	711	—	2133	—	—	—
	M.S.R. and M.L.H.	—	—	128	242	327	—	—	—	—	—	—	—	498	1422	2133	—
	L.H.	—	—	—	185	299	—	—	—	—	—	—	—	—	711	1778	-
	S.R.	—	—	—	185	299	—	—	—	—	—	—	—	—	924	2133	—

Netherlands	O.	—	—	—	256*	370	—	—	—	—	—	—	—	—	2845*	4267	—	
	R.H.	—	—	327	370	455	—	—	—	—	—	—	—	3555	4980	6045	—	
Norway	O.	—	—	228*	312	384		—	—	—	—	—	—	2560*	3555	4980		
	R.H.	—	256	—	384	427	—	—	—	—	—	—	3555	—	5330	6400	—	
Palestine	O.	—	—	284	356	—	—	—	—	—	—	—	—	1565	2489	—	—	
	R.H.	284	—	427	—	—	—	—	—	—	—	1565	—	3485	—	—	—	
Poland†	O.	—	—	—	—	—	—	—	—	427	711	—	—	—	1849	3555	—	
	H.S.	—	—	498	640	925	—	—	—	—	—	—	—	2845	4267	5689	—	
Portugal	L.S.	—	—	—	171	228	—	—	—	—	—	—	—	—	2133	3414	—	
	O.	—	—	—	242	299	—	—	—	—	—	—	—	—	2845	4267	—	
	L.H.	—	—	—	242	299	—	—	—	—	—	—	—	—	2845	4267	—	
	S.R.	—	—	—	242	299	—	—	—	—	—	—	—	—	2845	4267	—	
Roumania	O.	—	—	—	312	398	498	—	—	—	—	—	—	—	3124	3980	4980	
	H.S.	—	—	427	—	—	640	—	—	—	—	—	—	4266	—	—	6400	
	R.H.	—	—	356	498	—	—	—	—	—	—	—	—	—	4266	—	—	
Russia	O.	—	—	—	172	228	—	—	—	—	—	—	—	—	1890	—	—	
	R.H.	—	—	312	384	455	—	—	—	—	—	—	—	4697	7110	8540	—	
Spain	O.	—	—	—	270	335	—	—	—	—	—	—	—	—	2708	3980	—	
Sweden	O.	—	—	—	—	—	—	—	—	640	924	—	—	—	3556	5689	—	
	R.H.	—	—	—	—	—	—	427*	853	924*	996	2133*	—	4622	5689*	7112	—	
	L.H.	—	—	—	—	—	—	—	—	427*	711	—	—	—	2133	3911	90 days 5689	
Switzerland	O.	—	—	—	—	—	—	—	—	498	640	—	—	—	2560	3911	—	
	H.S.	—	—	—	—	—	—	—	569	711	853	—	—	3556	4836	5974	—	
Turkey	O.	—	—	—	313	384	455	—	—	—	—	—	—	—	4267	4978	5689	
	R.H.	—	—	384	—	484	597	—	—	—	—	—	—	4978	—	6045	7467	
U.S.A.**	O.	—	—	150	275	350	—	—	—	—	—	—	—	900	1800	3000	—	
	(M.S.R.,-M.L.H.)	—	—	125	250	325	—	—	—	—	—	—	—	750	1500	3000	—	
	R.H.	275	—	375	—	—	—	—	—	—	—	1250	—	2500	—	—	—	
	L.H.	—	—	—	175	300	—	—	—	—	—	—	—	—	800	2000	—	
	S.R.	—	—	—	175	300	—	—	—	—	—	—	—	—	1000	2200	—	
Uruguay	O.	—	—	—	—	—	—	—	—	—	—	—	—	—	2133	—	—	
	R.H.	—	—	—	—	—	—	—	—	—	—	1565	—	—	4409	—	—	
Venezuela	O.	—	—	—	284	356	—	—	—	—	—	—	—	—	—	—	—	
Yugoslavia	O.	—	—	—	228	—	398	—	—	—	—	—	—	—	2845	3982	4551	
	H.S.	—	284	—	398	—	—	—	—	—	—	—	—	—	5689	—	—	

† 2 : 1 mortar. ‡ 2·77 : 1 mortar. ** 2·75 : 1 mortar.

Recent Revisions of Specifications for Portland Cement.

British Standard for Low-heat Portland Cement.

Alterations have been made recently to the method described in British Standard No. 1370 for the determination of the heat of hydration (see this journal March, 1948).

If a 1-pint flask 150 mm. by 75 mm. is unobtainable, it is permissible to use a flask 150 mm. by 75 mm. for the calorimeter. Such a flask can be obtained by cutting a standard 200 mm. by 75 mm. flask to a length of 150 mm. Reference to British Standard No. 1370 should be made when ordering these special flasks.

The expression used to calculate the heat capacity in calories per degree has been altered to $\frac{\text{Weight of Zn.O (gm.)}}{\text{Corrected temperature rise}}$ $(259{\cdot}1 - 0{\cdot}2\,\theta + 0{\cdot}1\theta_0)$, where θ is the final temperature of the calorimeter and contents and θ_0 is the room temperature, the temperatures being in degrees Centigrade.

Australian Specification for Portland Cement.

The Australian Standard Specifications for Portland cement and high-early-strength (rapid-hardening) Portland cement were revised in 1948 and the requirements (with tolerances in brackets) are: Loss on ignition, not more than 3 per cent. (0·15 per cent.); insoluble residue, not more than 10 per cent. (0·15 per cent.); sulphuric anhydride, not more than 2·75 per cent. (0·10 per cent.); magnesia, not more than 4 per cent. (0·25 per cent.). The setting times as determined by the Vicat apparatus are: Initial set in not less than one hour, and final (or hard) set in not more than 12 hours. The soundness is tested by a hot-pat test (175 deg. to 200 deg. Fahr. for 24 hours). Expansion is tested by the Le Chatelier apparatus, the maximum expansion being 5 mm. or, if this is exceeded, not more than 2·5 mm. after a further six days' aeration. No fineness or tensile tests are prescribed. The compressive strengths (in pounds per square inch) of 2·783-in. cubes must be not less than 2500 at three days, 3500 at seven days, and 4500 at 28 days for ordinary Portland cement, and not less than 4000 at three days, 5500 at seven days, and 6500 at 28 days for rapid-hardening Portland cement.

Polish Specification for High-quality Cement.

A revised standard specification for ordinary Portland cement was published in Poland in 1946 (see this journal for September, 1947), and in 1948 a new specification for a Portland cement of higher quality was published. The new standard requires the residue on a sieve having apertures of 0·2 mm. to be not more than 1 per cent., and not more than 10 per cent. on a sieve having apertures of 0·08 mm. The initial and final setting times are the same as for ordinary Portland cement, that is not less than 40 minutes and not more than 10 hours respectively. The chemical composition must comply with the following: SO_3 not more than 3 per cent.; MgO, not more than 5 per cent.; insoluble residue, not more than 1·5 per cent.; and loss on ignition, not more than 3 per cent. The minimum tensile strengths required are 498 lb. per square inch at three days, 640 lb. per square inch at seven days, and 925 lb. per square inch at 28 days. The compressive strengths required at the corresponding ages are 2,845 lb., 4,267 lb., and 5,689 lb. per square inch.

Chemical Analysis in the Cement Industry.

Argillaceous Materials.*

DETERMINATION OF SULPHATE.—Of the sample, 1 gr. is placed in a porcelain dish, 30 cc. of water and 10 cc. of concentrated hydrochloric acid are added, and boiled for ten minutes. The solution is then filtered through a 9-cm. No. 40 Whatman filter paper into a 400-cc. conical beaker. The filter is washed with hot water until it is free from chloride. The filtrate is brought to the boil and, if perfectly clear, 10 cc. of hot barium-chloride solution (122 gr. per litre) are added gradually, boiling is continued for five minutes, and the filtrate is then allowed to stand in a warm place for six hours. The $BaSO_4$ precipitate is filtered out through a double 9-cm. No. 42 Whatman filter paper and washed with hot water until it is free from chloride. The filter is placed in a weighed porcelain crucible, the paper slowly charred and burnt off without inflaming, and finally ignited at 800 to 900 deg. C., cooled, and weighed.

The weight of $BaSO_4 \times 34{\cdot}3$ *is the percentage of* SO_3.

DETERMINATION OF SULPHIDE.—Of the sample, 1 gr. is placed in a 250-cc. beaker, and 300 cc. of water and 3 or 4 drops of pure bromine are added. The beaker is covered, and allowed to stand in the fume cupboard for ten minutes; 10 cc. of concentrated hydrochloric acid are added. and the contents of the beaker boiled until all excess bromine is removed. The solution is then filtered through a 9-cm. No.1 Whatman filter paper, washed until it is free from chloride and, after ensuring that the filtrate is perfectly clear, barium sulphate is precipitated as already described.

(*Total weight of* $BaSO_4$ *less the weight of* $BaSO_4$ *equivalent to* SO_3) $\times$ 13·74 *is the percentage of sulphides.*

DETERMINATION OF LOSS ON IGNITION.—Of the sample, 1 gr. is weighed in a platinum crucible or capsule and heated gradually in a muffle furnace to 1000 deg. C. The heating is maintained at this temperature for thirty minutes. The crucible or capsule is covered during the early stage of heating, but for the last thirty minutes the lid is removed. The crucible or capsule is then cooled and weighed.

The loss in weight $\times$ 100 *is the percentage loss on ignition.*

This loss on ignition requires correction for possible changes in the sulphates, chlorides, alkalis, and sulphides in the process of ignition. These groups are determined in the ignited sample by the methods already described. In order to obtain all the corrections it will be necessary to ignite more than 1 gr. of the original sample. Normally there will be no sulphide present in the ignited sample. If the sulphide (S) is replaced by O, the loss on ignition is reduced by half of the sulphide replaced. If the sulphide (S) is oxidised to SO_4 the loss on ignition is increased by twice the amount of sulphide oxidised.

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* Continued from March, 1949.

DETERMINATION OF CARBON DIOXIDE.—The apparatus consists of a 250-cc. round-bottomed flask fitted with a stoppered separator funnel and delivery tube, to which is attached an upwardly inclined condenser followed by a drying system consisting of three U tubes containing granular calcium chloride, anhydrous copper sulphate, and calcium chloride respectively. These are followed by the carbon-dioxide absorption, potash bulb, and soda-lime guard tube, and finally these are connected to a large aspirator through a further calcium-chloride tube. Arrangements are also made to attach a soda-lime tower and sulphuric-acid bubbler before the stoppered separator funnel, so that a current of CO_2– free air can be passed through the apparatus. The sulphuric acid bubbler will show the rate of gas flow through the apparatus.

Of the sample, 5 gr. are placed in the round-bottomed flask and thoroughly mixed with 50 cc. of hot water. The flask is then fitted into the apparatus, the CO_2-absorption unit (potash bubbler and soda-lime guard tube) being disconnected. Having proved that the remainder of the apparatus is air-tight, the system is aspirated for about one hour to ensure that the air it contains is free from CO_2. The weighed CO_2-absorption unit is then inserted in the train, 20 cc. of concentrated hydrochloric acid are placed in the separator funnel, the aspirator is started, and the taps of the drying system opened successively from the aspirator-bottle end of the apparatus. Acid from the separator funnel is slowly admitted to the round-bottomed flask, its rate being adjusted to about one bubble per second in the sulphuric-acid bubbler. When the action of the acid has ceased, the tap of the separator funnel is fully opened and the flask is gradually heated until its contents boil, care being taken to maintain a steady rate of air bubbling through the apparatus. Boiling is continued for ten to fifteen minutes, when the burner is extinguished and the apparatus aspirated for a further hour, after which all the taps are closed. The potash bulb and soda-lime guard tube are disconnected and left in the balance case for half an hour before weighing.

The increase in weight $\times$ 20 *is the percentage of* CO_2.

DETERMINATION OF CARBON.—The apparatus is similar to that used for the determination of carbon dioxide, the round-bottomed flask and condenser being replaced by a combustion furnace containing a platinum star. The absorption is made in an atmosphere of oxygen, the supply being connected to the inlet tube of the soda-lime tower.

Of the sample, 5 gr. are placed in a porcelain boat and inserted in the combustion furnace, which has been previously burnt out and the air inside freed from CO_2 by aspirating in the usual way. The weighed potash bulb and guard tube are attached, and the aspirator started. The taps of the drying system are opened successively from the aspirator-bottle end of the apparatus and the oxygen admitted at the rate of one bubble per second in the sulphuric-acid bubbler. The burners under the combustion tube are lighted, beginning at the end nearest the aspirator bottle and farthest from the boat. The temperature is raised to full heat in the course of about half an hour in order that the carbon dioxide formed be

not driven off too rapidly. Full heat is maintained for a further half an hour, at the end of which time the burners and the oxygen supply are shut off and the train aspirated for one hour. The ignited material is then transferred from the porcelain boat to a 250-cc. round-bottomed flask which is inserted into the apparatus for determining carbon dioxide as previously described. Any residual carbon dioxide remaining in the ignited sample is then driven off and absorbed in the same manner as before.

The difference between the carbon dioxide only and that plus the amount from the combustion is the carbon dioxide derived from the ignition of carbonaceous matter, and this amount multiplied by 5·454 gives the percentage of carbon.

The loss on ignition can now be divided into carbon dioxide, carbon, and combined water.

DETERMINATION OF CHLORIDES.—Of the sample, 5 gr. are placed in a 400-cc. porcelain dish, 30 cc. of water and 10 cc. of concentrated nitric acid are added, and the contents of the dish boiled for ten minutes. The solution is then filtered through a No. 41 Whatman filter paper and the filter well washed, the filtrate being caught in a conical beaker. The filtrate is neutralised with pure calcium carbonate, again filtered, and the residue well washed. The filtrate is cooled, and titrated with N/10 silver nitrate, using a 1-per cent. solution of potassium chromate as indicator. A blank determination, following the same procedure and using the same amounts of reagents, is made and the results obtained in the analysis are corrected accordingly.

If the amount of chlorine as chlorides is considerable the loss on ignition figure should be corrected by the oxygen equivalent of the chlorine found.

DETERMINATION OF FORMS OF SILICA IN ARGILLACEOUS MATERIALS. — Two grammes of the clay are placed in a 4-in. porcelain basin, moistened with a little water, and about 20 cc. of concentrated sulphuric acid are added. The contents of the basin are heated over a hot plate for eight to ten hours and then evaporated to dryness in a fume cupboard. After cooling, the mass is extracted with water, filtered on a 9-cm. No. 41 Whatman filter paper and well washed. The filter and contents are then transferred to a tared platinum crucible, partially dried, the carbon of the paper completely consumed without inflaming, and finally ignited at 900 to 1000 deg. C. for twenty minutes. This gives the silica in combination with the bases of the clay (A) + hydrated silicic acid (B) + quartz sand and undecomposed silicates (C).

The ignited residue is then transferred in small portions to a porcelain dish containing a boiling solution of approximately 50 cc. of 13 per cent. sodium-carbonate solution. When all the residue is transferred to the dish it is boiled for a few minutes and then filtered on a 9-cm. No. 41 Whatman filter paper, retaining the residue in the dish. A further 50 cc. of sodium-carbonate solution are added, and the contents are again boiled and filtered. This is repeated until a few drops of the filtrate remain clear on warming with ammonium-chloride solution. The residue is then transferred to the filter, washed first with hot water, then with water slightly

acidified with hydrochloric acid, and finally with water until it is free from chloride. The filter and contents are then transferred to a tared platinum crucible, dried, ignited, and weighed. This residue will consist of quartz sand and undecomposed silicates (C).

To determine the quartz sand, the ignited residue (C) is treated with hydrofluoric acid and sulphuric acid to remove the silica, the residue is dissolved in water or by fusion with sodium carbonate if necessary, and the alumina is precipitated in the normal manner.

The weight of ignited alumina × 5·4 *is the weight of felspar, and this deducted from the original residue* (*C*) *is the weight of quartz sand.*

To determine the hydrated silicic acid 2 gr. of the clay are extracted directly with 13 per cent. sodium-carbonate solution in a porcelain basin, as already described. The filtrate is acidified with hydrochloric acid, evaporated to dryness, and the silica determined in the ordinary manner.

Calcareous Materials.

SAMPLING.—The preparation of a sample is carried out in a similar manner to that described for argillaceous materials. The sample is examined qualitatively for solubility in acid. If, from observation, it appears to contain more than 5 per cent. of insoluble matter it is advisable to analyse it by the methods described for argillaceous materials. If the insoluble matter appears to be less than 5 per cent. the analysis is made in the following manner.

DETERMINATION OF SILICA.—Two grammes of the sample are placed in a 6-in. porcelain dish, and 1 gr. of ammonium chloride and 10 cc. of water are added. The dish is covered with a clock glass, and 10 cc. of concentrated hydrochloric acid are carefully added. The contents of the dish are thoroughly mixed by means of a rubber-tipped glass rod, all lumps being broken, and allowed to simmer on a hot plate for half an hour. The dish is then removed from the hot plate and the cover is washed in with as little water as possible, using the rubber-tipped glass rod to detach all adhering particles. The contents of the basin are then evaporated to dryness on a hot plate or water bath. When the contents are quite dry the covered basin is allowed to cool, 15 cc. of concentrated hydrochloric acid are added slowly, followed by 15 cc. of hot water, and the contents of the basin are then heated just short of boiling. The contents are then filtered through a 9-cm. No. 41 Whatman filter paper into a 500 cc. graduated flask. The basin is rubbed clean with the rubber-tipped glass rod, rinsed out into the filter and, when all the silica is on the filter, it is washed with hot 1 : 3 hydrochloric acid and then with hot water until it is free from chlorides. The filtrate is transferred back to the porcelain basin and again evaporated to dryness, and this process is repeated, the contents being filtered through another No. 41 Whatman filter paper into the same graduated flask. Both filter papers are partially dried in a weighed platinum crucible, the papers smoked off over a low flame and finally ignited at 1100 to 1200 deg. C. in a muffle for half-an-hour. After cooling and weighing, the precipitate is moistened

with water and 2 cc. of 1 : 3 sulphuric acid and about 4 cc. of hydrofluoric acid are added. The contents are evaporated slowly in a fume cupboard until no further fumes are evolved. The crucible is then ignited, gently at first and finally for fifteen minutes in a muffle at 1100 to 1200 deg. C. The crucible is then cooled and weighed.

The loss in weight × 50 *is the percentage of silica.*

The residue remaining in the crucible is carefully fused over a low flame with six or seven times its weight of potassium bisulphate. The melt is cooled, taken up with hot water, and finally dissolved out with 1 : 1 hydrochloric acid. This solution and washings are added to the main solution in the graduated 500-cc. flask. The solution in the flask is cooled to room temperature, made up to the mark, thoroughly mixed, and divided into two equal parts by pouring half of it into a clean and dry 250-cc. graduated flask.

One 250-cc. portion is used for determination of R_2O_3, lime, and magnesia, and the other portion for Fe_2O_3, the determination being made according to the methods described for argillaceous materials. Sulphates, sulphides, loss on ignition and the parts thereof, alkalis, etc., are also determined by the methods previously described.

DETERMINATION OF LEAD AND ZINC.—The materials should be examined for the presence of lead and zinc. A rapid qualitative test may be made as follows. Into about 50 cc. of hot ammonium-acetate solution add gradually 10 gr. of the powdered material. Allow the solution to simmer on a hot plate until the reaction appears to have ceased. Filter through a No. 41 Whatman filter paper and wash well with hot water. Pass hydrogen sulphide through the filtrate until no further precipitation occurs. Boil and filter through a No. 41 Whatman paper. Retain the filtrate for examination for zinc. Wash the precipitate retained on the filter with ammonium sulphide followed by a little hot water. Transfer the residue on the filter to a small beaker and digest with hot dilute nitric acid. Filter and test the filtrate with dilute sulphuric acid. A white precipitate indicates the presence of lead.

The filtrate from the hydrogen-sulphide treatment is freed from H_2S by passing carbon dioxide through the hot solution until the vapour no longer blackens lead-acetate paper. Add freshly prepared potassium-hydroxide solution until a faint permanent precipitate appears. Acetic acid is then added to dissolve this precipitate and 5 cc. are added in excess. Pass hydrogen sulphide through the resulting solution for forty minutes. Boil to coagulate any precipitate and then filter through a No. 41 Whatman filter paper. Wash the precipitate well with hot water, transfer it to a small beaker, and dissolve the precipitate in hot dilute hydrochloric acid. Filter and test the filtrate with potassium-ferrocyanide solution. A white precipitate indicates the presence of zinc.

Quantitative estimation of these two elements, if found to be present by these tests, may be made as follows:

Lead.—Five grammes of the finely-ground sample are dissolved in the smallest amount of hydrochloric acid possible. The solution is filtered and washed with

hot water. The filter and residue are partially dried and the carbon of the paper completely consumed without inflaming in a platinum crucible. The residue is treated with hydrofluoric acid and sulphuric acid, in the manner already described to remove free silica. The residue after this treatment is then rendered soluble by fusion with sodium carbonate, dissolved out with hydrochloric acid, and added to the main filtrate. The solution is then reduced with about 1 gr. of sodium sulphite with warming until it is colourless. Excess sulphur dioxide is removed by passing carbon dioxide through the hot solution. When it is free from sulphur dioxide, as tested with potassium dichromate paper, sulphuretted hydrogen is passed through the hot solution until no further precipitate occurs. The solution is then boiled and filtered on a No. 40 Whatman filter paper of a suitable size. The filtrate is retained for determination of zinc. The residue remaining on the paper is washed with ammonium sulphide and then with hot water. It is then transferred to a small beaker and digested with hot dilute nitric acid. The solution is then filtered and washed. The filtrate is finally treated with dilute sulphuric acid until precipitation is complete. The precipitated lead sulphate is filtered off, washed with dilute sulphuric acid, ignited at a dull red heat, cooled, and weighed.

The weight of lead sulphate × 14·72 *is the percentage of PbO.*

Zinc.—The filtrate from the precipitation of lead sulphide is freed from sulphuretted hydrogen by passing carbon dioxide through the hot solution until the vapour no longer blackens lead-acetate paper. Freshly-prepared caustic potash solution is then added until a faint permanent precipitate appears. Sufficient acetic acid is then added to dissolve this precipitate and 5 cc. are added in excess. Sulphuretted hydrogen is then passed rapidly through the resulting solution for forty minutes after cooling to 50 deg. C. or less. The precipitated zinc sulphide is then coagulated by boiling the solution and then filtering it. After being well washed, the precipitate is taken up with hot dilute hydrochloric acid; 0·03 milligramme of ferrous iron in the form of a ferrous-ammonium-sulphate solution is then added, and diluted to about 200 cc. The solution is heated to boiling and titrated as follows. About 50 cc. of the solution are reserved in a small beaker and standard potassium-ferrocyanide solution (1 cc. = 0·005 gr ZnO) is added to the main solution while vigorously stirred. The solution will have a blue colour which changes to a creamy white when an excess of ferrocyanide is added. A few cubic centimetres more of ferrocyanide solution are added, and the remainder of the reserved portion of the zinc solution, with the exception of 5 cc. to 10 cc. Ferrocyanide solution is again added until the end-point is reached. The last of the reserved zinc solution is then added and the ferrocyanide solution added drop by drop until the blue colour fades sharply to a pea green. This is then the end-point of the titration.

The number of cubic centimetres of standard ferrocyanide solution × 0·1 *equals the percentage of ZnO.*

(*To be continued*)

The Cement Industry in Germany

WE have received the following from Fachverband Zement, of Frankfurt, Germany, which is the organisation responsible for the export of cement from Western Germany.

" In an article by Dr. Hans Kühl in your January number, which was reproduced in " Zement-Kalk-Gips," it is suggested that the German cement factories are in very poor shape, and are unable to produce good quality cement. We are of the opinion that Dr. Kühl referred only to conditions of the cement factories in the Russian occupied Zone where he is living. So far as the cement factories in the Western Zones are concerned, every effort has been made to get them into an efficient condition, with the support of the Occupation Powers, whose help, and that of the British authorities especially, is fully acknowledged and appreciated.

" Although some of the raw materials and plant are rationed or hard to get, the cement factories have been able to produce a cement which is satisfactory in quality. The cement industry of Western Germany is now exporting cement, and can guarantee that it complies with British Standard Specification No. 12/1947. Deliveries have been made to the United Kingdom without complaints. During the first three months all deliveries were tested in advance, and the results were so satisfactory that now such tests are made only from time to time from current production."

IN connection with the foregoing we have received a statement from the Export Department of the Cement Marketing Co., Ltd., as follows :

" The Cement Marketing Co. have, during the past six months, bought 200,000 tons of German Portland cement and clinker from fourteen factories in the British and American Zones, and we are now in the process of making a further contract with the same factories for an additional 100,000 tons."

" When negotiating the first contract in July 1948 we had reports that the quality of German post-war cement was considerably below standard, and it was thought doubtful whether it complied with the British Standards. We therefore included in the contract very strict conditions for testing this cement. Arrangements were made with Mr. H. Stanger to sample each 250 tons, and shipment was only allowed to go forward after it was confirmed that the cement had passed the tests of the British Standards. Tests were also made on the clinker."

" We can state that there has been no serious case of any of this German cement not passing the British Standard tests. One or two minor cases have occurred, but, in the opinion of Mr. Stanger, these do not alter his view that the cement obtained at present from the German works concerned is of good and uniform quality."

Dr. Hans Kühl, to whom a copy of the letter from Fachverband Zement was sent, writes as follows :

" The letter of the Export Bureau of the German Cement Association may give the impression that I had considered unfavourably the efficiency of the

German cement industry. That is not so. When I mentioned the difficulties with which our cement industry had to contend at the end of the war, I did this simply with the object of showing how it was possible that the American experts could consider our German cements as inferior to the American and English cements, in spite of the good results obtained in the Autobahnen. My statements, therefore, amounted to a defence of the German cements. How justified this defence was is proved by the statements of the Export Bureau, which show that the German cement industry was able to overcome the war damages and to regain its old efficiency comparatively quickly."

MISCELLANEOUS ADVERTISEMENTS.

SCALE OF CHARGES.

Situations Wanted, 3d. a word; minimum 7s. 6d.
Situations Vacant, 4d. a word; minimum 10s.
Box number 1s. extra. Other miscellaneous advertisements, 4d. a word; 10s. minimum.
Advertisements must reach this office by the 5th of the month of publication.

COLONIAL DEVELOPMENT CORPORATION.

SITUATIONS VACANT.—The Colonial Development Corporation invites applications from candidates for the appointment of Deputy Divisional Manager, Processing and Deputy Divisional Manager, Manufacturing under the Divisional Manager of Factories.

Candidates are required to be fully qualified engineers with sound commercial experience. The Deputy Divisional Manager Processing will be required to deal with projects concerning the processing of chemicals, food preservation, oil pressing, etc. The Deputy Divisional Manager Manufacturing will deal with projects concerning the manufacture of cement, building materials, textiles, sacks, general engineering, etc. A knowledge of estimating, works costing and plant layout is essential.

The salary will depend upon qualifications and experience, but will be between £1,500 and £1,750 per annum. Age limits 32 to 48. There will be a superannuation scheme. Periodical visits to tropical climates will be involved, but the appointments will be based in London.

Applicants should write giving a full statement of age, education, present occupation and duties, past appointments, and any other relevant particulars in chronological order. References should be given but these will not be taken up without the concurrence of the candidate. Closing date will be 31st May, 1949. Applications should be addressed to the Personnel Manager, 33, Dover Street, London, W.1.

SITUATION VACANT. Ribblesdale Cement, Ltd., require senior experienced chemical engineer to take charge of the complete chemical control of their works at Clitheroe, Lancs. Applicants should preferably have working experience in the manufacture of cement from hard raw materials. Salary £750 to £900 per annum according to qualifications.—Reply, giving details of experience, to Ribblesdale Cement, Ltd., 105, Piccadilly, London, W.1.

SITUATION VACANT. Engineer with up-to-date experience in cement machinery and cement manufacture required for Hong Kong. Age under 35 years. Commencing salary HK. $700 monthly, rising progressively to HK. $1,025 monthly, plus high cost of living allowance, free furnished quarters, passage paid. Provident Fund.—Reply stating qualifications and experience, Box 1981, Cement and Lime Manufacture, 14, Dartmouth St., Westminster, S.W.1.

WANTED. Hardinge conical ball mill size 54 in. by 16 in., complete with driving motor for 400/3/50 supply. Box 1982, Cement and Lime Manufacture, 14, Dartmouth Street, Westminster, S.W.1.

CROWN AGENTS FOR THE COLONIES.

Applications from qualified candidates are invited for the following posts:—

BURNER. Required by Government of Ceylon for Cement Factory, Kankesanturai, in course of construction. Salary £600 per annum fixed. Cost of living allowance Rs. 70 a month payable. Post is non-pensionable, but Provident Fund exists. Possibility agreement may be renewed. Government quarters provided at rental of 6 per cent. of salary; free passages out and home for officer and family; leave, travelling allowance, etc., in accordance with regulations. Five years' agreement. Candidates, aged 35-50, must have had long experienced in rotary kiln burning, wet and dry processes, preferably with knowledge of oil and coal firing equipment, and be capable of taking over from chief burner as required.— Apply at once by letter stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/21447/3E on both letter and envelope.

ASSISTANT MANAGER/CHEMIST. Required for the Cement Works, Chilanga, Northern Rhodesia, for three years in the first instance. Salary £1,200 a year. Free partially furnished quarters and free passages. Candidates, age 35 to 50, must have had considerable experience as chemists in the cement industry, including control of production. They should be capable of organising and running the works' laboratory of a modern wet-process plant. Experience should include control of kilns, loading and testing of mills, and control of quality. Professional qualifications as an industrial chemist an advantage. The officer will be responsible for the supervision of manufacture through all stages from the raw materials to finished product.—Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/22358/3E on both letter and envelope.